REPORT DOCUMENTATION PAGE

AD-A211 359	**1b. RESTRICTIVE MARKINGS** THIS FILE COPY
2b. DECLASS... LE	**3. DISTRIBUTION/AVAILABILITY OF REPORT** Approved for public release; Distribution unlimited

4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S)
GL-TR-89-0199	

6a. NAME OF PERFORMING ORGANIZATION	6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION
Geophysics Laboratory	LIU	

6c. ADDRESS (City, State, and ZIP Code)	7b. ADDRESS (City, State, and ZIP Code)
Hanscom AFB Massachusetts 01731-5000	

8a. NAME OF FUNDING/SPONSORING ORGANIZATION	8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER

8c. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS			
	PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION NO.
	62101F	4643	11	01

11. TITLE (Include Security Classification)
UV Ionospheric Remote Sensing With the Polar Bear Satellite

12. PERSONAL AUTHOR(S)
F.P. DelGreco, R.W. Eastes, R.E. Huffman

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Reprint	FROM _____ TO _____	1989 August 8	5

16. SUPPLEMENTARY NOTATION
Reprinted from SPIE, Paper No. 1158-06

17.	COSATI CODES		18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Ultraviolet; Airglow; Aurora; Space Sensors; Remote Sensing

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This paper presents a brief description of some recent work interpreting and analyzing data obtained by the AIRS sensor on the Polar BEAR satellite.

DTIC
ELECTE
AUG 16 1989
D

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT	21. ABSTRACT SECURITY CLASSIFICATION
☐ UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT. ☐ DTIC USERS	Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL Francis DelGreco	**22b. TELEPHONE (Include Area Code)** (617) 377-4758 **22c. OFFICE SYMBOL** LIU

DD FORM 1473, 84 MAR   83 APR edition may be used until exhausted.   SECURITY CLASSIFICATION OF THIS PAGE
All other editions are obsolete.

89   8   16   030   Unclassified

UV IONOSPHERIC REMOTE SENSING
WITH THE POLAR BEAR SATELLITE

F.P. DelGreco, R.W. Eastes and R.E Huffman

Geophysics Laboratory/LIU (AFSC)
Hanscom AFB MA 01731

ABSTRACT

This paper presents a brief description of some recent work interpreting and analyzing data obtained by the AIRS sensor on the Polar BEAR satellite.

1. INTRODUCTION

The Polar BEAR satellite was launched in November 1986 into a nearly circular 1000 km orbit with an orbital inclination of 89.5 degrees and a nodal regression of 0.05 degrees per day. In the course of a year the satellite experiences all local times twice a year. One of the instruments on Polar BEAR is the Auroral Ionospheric Remote Sensor (AIRS). AIRS has been described previously[1] and some of the early data from that instrument also has been presented[2]. Briefly, in its primary operating mode AIRS was designed to return four simultaneous images of the atmospheric radiation at Northern latitudes, in the far and near near ultraviolet (UV) and the visible at 6300 A. Two of the data streams originate from photomultipliers at the exit plane of a one eighth meter far UV spectrometer. The other two data streams originate at photomultipliers behind narrow band UV and visible filters. A single telescope illuminates both the spectrometer entrance slit and the filtered detectors. In the normal imaging mode of operation, on a three second cycle the line of sight of all four channels is deflected from horizon to horizon perpendicular to the orbital path by a plane mirror at the entrance to the telescope. In pushbroom fashion the successive line scan strips build up an image as the satellite proceeds in its orbit. At nadir there is about ten percent overlap between successive line scans; the nadir footprint is about twenty two km (along track) by four km (cross track). As stated above, the normal operating mode is imaging, but AIRS also has collected (nadir) data scanning the spectrum from 1100 A to 1800 A. In addition it also has been used as a nadir sensing photometer emphasizing high spatial resolution as described in another paper at these Proceedings[3]. Figure 1. presents an outline of the various modes of operation and featured wavelengths used by AIRS up to the present time. Both Polar BEAR and the AIRS instrument itself have experienced on orbit anomalies as time has progressed and those problems account for the various "off" periods and the reduction in the number of data channels collected as shown in Figure 1. Reference 2 discusses some of these issues. Nonetheless over five thousand images already have been collected and are now being processed for efficient access on an optical disk data base. More will be added as performance of the hardware in space allows.
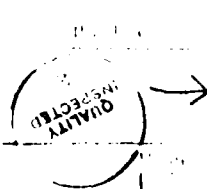
2. APPLICATIONS OF AIRS IMAGE IMAGER DATA

2.1 Excitation processes

Our main purpose in developing and flying sensors such as AIRS and its short lived predecessor AIM[4] is to explore the use of UV imagery as a tool for passive remote sensing of the state of the ionosphere. Doing so with spectral resolution of 30 - 36 A as in this instrument makes it possible to obtain data with sufficient spectral purity that quantitative tests of atmospheric excitation models can be made. One such test is described by Decker et.al.[5] who compared daytime midlatitude electron density profiles deduced from AIRS satellite UV measurements with incoberent scatter radar "ground truth" with some success. In this case the excitation was provided by solar illumination. In contrast, in the auroral and polar cap region under full night time conditions the source of excitation will be energetic particles, often primarily electrons. Strickland and coworkers[6] have been developing excitation models for the auroral radiation, both UV and visible. For our purposes we concentrate on contributions from the atomic oxygen transition at 1356 A and the Lyman - Birge - Hopfield (LBH) bands of molecular nitrogen near 1600 A as well as the nitrogen molecular ion radiation in the (0,0) transition of the first negative bands at 3914 A. One of the parameters it is possible to deduce from the relative brightness of these features is the characteristic energy, E_0, of the incident electrons. (E_0 is a way of describing the distribution of energies of the incoming electrons). In this work we have adapted our standard image processing techniques to provide a two dimensional display of the E_0 calculated from application of model results to imager data. Figure 2. sets the stage for discussion of one such case. The original illustration represents in false color the observed brightness of the atomic oxygen 1356 A radiation over the full longitudinal width of the scan made by AIRS as it passed over Greenland early (UT) on 30 January 1987. The planetary activity index Kp for the three hour period spanning the measurement time was a modest 2-. The subsequent analysis was restricted to the central 2000 km of the scan to make full use of the available data in that part of the image and to avoid complications in interpreting radiation transport through long slant paths at the edges of the field of view.

It is recognized that both normal airglow and auroral components contribute to the observed brightness in each scene (i.e.color). In processing the data shown we assigned the brightest 25 percent of the pixels to the auroral component and treated each color in a consistent manner thereafter. The "auroral" components were passed through a seven pixel wide running average filter both vertically and horizontally. This was done to improve the statistics of the weakest channel (LBH at 1596 A) to an average uncertainty of less than ten percent. After rescaling to a uniform brightness range (noting how much each had been amplified) brightness ratios 1356/3914, 1596/3914 and 1596/1356 were determined on a pixel by pixel basis for the pairs of filtered images.The brightness ratios, properly scaled, were then interpreted as E_0 values and displayed on the screen. The results for two of these are shown in Figures 3 and 4. In the original false color presentation it is easy to see that there is agreement to within 30 percent over nearly the entire regin studied. The results for the 1596/1356 case are less reliable; many more of the brightness ratios used

could not be interpreted within the range of allowed values and those that could often yielded E_0 values up to a factor of two higher than for the corresponding regions in the other cases. In several other tests of this method we have observed similar agreement - and disagreement - between the deduced values of E_0.

As elaborated by Strickland[6], there are limitations and sources of error introduced by using 3914 A radiation in this analysis, mainly related to uncertainty about the value of the albedo at that wavelength and its variability. Even so, the results to date are encouraging because the deduced values make sense and seem to provide a reasonable overall view of what is happening during the auroral event. Because the aurora is such a variable phenomenon, changing in detail from one minute to the next, and even more rapidly, knowing precisely what is going on at any given location at a particular moment probably is of limited use to to an ionospheric "weather" forecaster. The general indication of overall conditions over a wide area which further development of this technique is likely to provide may prove very useful indeed.

2.2 Monitoring the aurora

Ordinarily the aurora, while variable in brightness and detailed morphology, stays within the broad confines of the auroral zone at high latitudes; the location of its equatorward edge has been shown to have a statistical correlation with the index Kp. In work we are currently pursuing, that relation will be tested using the information in the data base of AIRS images. Earlier this year the Earth experienced the first of what promises to be many geomagnetic storms as we progress to and over the peak of solar activity in the current solar cycle. Polar BEAR was in operation during mid March when the preliminary Kp reached a value of nine over the six hour period spanning midnight (UT) on 13 - 14 March after growing steadily for several days. AIRS happened to be imaging at a wavelength of 1304 A (atomic oxygen) at the time and recorded the remarkable data shown in Figure 5. Polar BEAR is programmed to take data only to the north of 45 degrees north latitude, where its receiving stations are located. Forty five degrees is well the to the south of any normal auroral activity. In this case, because of the intense activity, the AIRS data is barely able to register the poleward edge of the aurora, with the main body of the aurora well to the sou. . . The full sequence of available images from that time period documents the advance ar retreat of the auroral activity as the geomagnetic conditions changed over time.

3. REFERENCES

1. Schenkel, F.W., B.S. Ogorzalek, R.R. Gardiner, R.A. Hutchins, R.E. Huffman and J.C. Larrabee, "Simultaneous multispectral narrowband auroral imagery from space (1150A to 6300A)", SPIE,687,90-103, 1986.

2. DelGreco, F.P. R.E. Huffman, J.C. Larrabee, R.W. Eastes, F.J. LeBlanc and C.I. Meng, "Organizing and utilizing the imaging and spectral data from the Polar BEAR", SPIE, 932, 30-35, 1988.

3. Papers by R. Wohlers et. al. and R. Hugenin et. al. in ULTRAVIOLET TECHNOLOGY III, SPIE, 1989.

4. Meng, C.I., and R.E. Huffman, "Ultraviolet imaging from space of the aurora under full sunlight", Geophys. Res. Lett., 11, 315-318, 1984.

5. Decker, D.T., J.M. Retterer, J.R. Jasperse, D.N. Anderson, R.W. Eastes, F.P. DelGreco, R.E. Huffman and J.C. Foster, "Determination of daytime midlatitude electron density profiles from satellite UV and in-situ data", SPIE, 923, 24-29, 1989.

6. Strickland, D.J., in ULTRAVIOLET TECHNOLOGY III, SPIE, 1989.

Figure 1. Summary of AIRS operating modes since launch in November 1986.
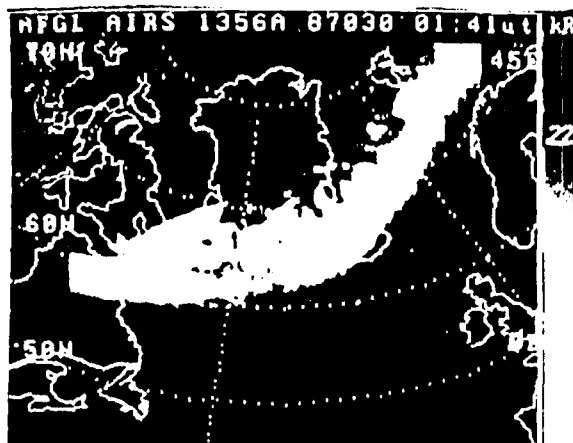
Figure 2. General view of auroral feature in 1356 A radiation on 30 Jan 1987 at 01:41 UT.
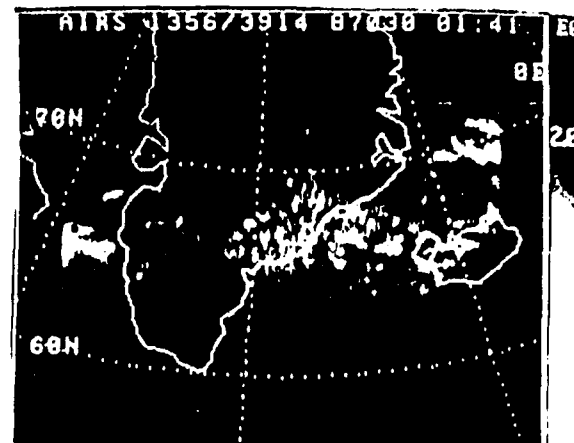
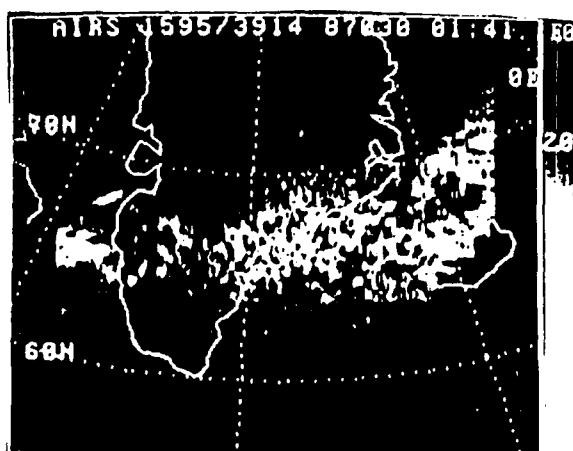Figure 3. Close up view of E_0 deduced for aurora shown in Fig. 1 from ratio of 1356 A to 3914 A radiation.

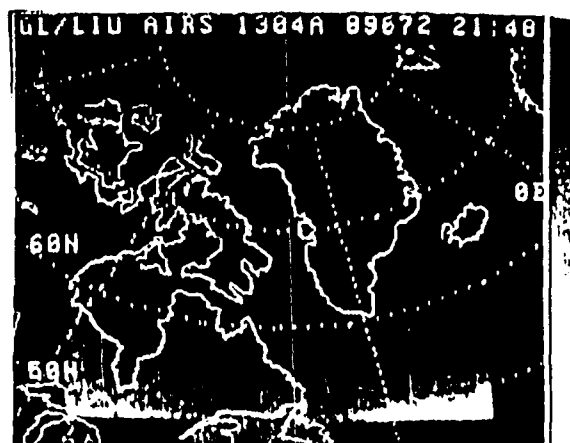Figure 4. Same scene as Fig. 3, E_0 deduced from 1596 A/3914 A ratio.

Figure 5. General view of auroral and polar cap features at peak of magnetic storm on 13 March 1989.